AMATEUR WORK

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ELEMENTARY SHOP PRACTICE.

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IV. SCRAPERS AND DRILLS.

Filing is generally satisfactory for surfaces which are fitted together, but where surfaces are exposed in the finished machine, it is customary to give them a better appearance by polishing. When using the finer file, care should be taken to lay all the file marks as nearly parallel as possible and usually in the direction of the length of the surface. Then the polishing is done with emery or a similar substance. Grain emery firmly glued to a cloth backing, called emery cloth, is generally employed, and may be wrapped around a file or block of wood. Several grades must be used, say Nos. 60, 90 and 120, and each should be first used dry and afterward wet with oil, which makes it cut finer and gives a better appearing surface. The last piece of cloth used should be worn quite smooth, and old pieces should be kept for this purpose. Lay the marks straight and parallel, and the result will be what is known as a grained surface. If a true polish is required, finish with emery paper, followed by rouge or rotten stone, which will leave a surface without marks of any kind. The coarser part of polishing is done in the same direction and manner as heavy filing, but the final touches are best given by a motion similar to draw-filing. Oil may be used in polishing cast iron, although not in filing or chipping it.

Polished surfaces on steel and iron are easily kept from rusting and tarnishing by keeping them covered with a film of oil, but when a surface is not to be handled, and especially if it be of brass or composition, it can be permanently protected by coating it with lacquer. This forms a hard transparent covering which keeps the air from the surface and thus prevents oxidization. The best lacquer is made by cutting flake shellac, either white or orange, in grain alcohol and filtering the liquid several times through blotting or filter paper. The work should be heated to about 200 F., and the lacquer applied in thin even coats with a camels hair brush. If the work is to be handled a great deal, each coat should be baked on in a hot oven. What are known as cold lacquers can be obtained for less money, and as they can be applied to cold work, either with a brush or by dipping and draining, they are often used where the best work is not required.

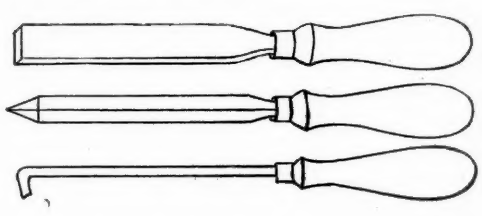


Fig. 29, Forms of Scrapers

We have seen that filing is usually satisfactory for surfaces to be in permanent contact, and that polishing serves to finish exposed surfaces. By another process, called scraping, filed surfaces may be much improved as far as their truth is concerned, and the process also serves to finish parts which would be difficult to polish. Scraping might be defined as locally removing small

amounts of metal; the idea of removing metal in spots destinguishes it from all other processes All kinds of metals may be scraped, and where one surface must accurately fit another such as, all sliding surfaces on machine tools, journals in brass or bronze boxes, etc., the use of the scraper insures close work.

When, in addition to being in contact over their entire area, it is necessary that two surfaces be plane surfaces, they are not fitted one to the other, but are each compared with an accurately scraped surface called a master plate. There must also be some means of indicating where the surfaces are in contact. This may be done by smearing the master plate with a thin even coating of red lead and oil, and when the piece being tested is rubbed over the plate, the red lead will adhere to the high spots which come in contact with the smeared surface.

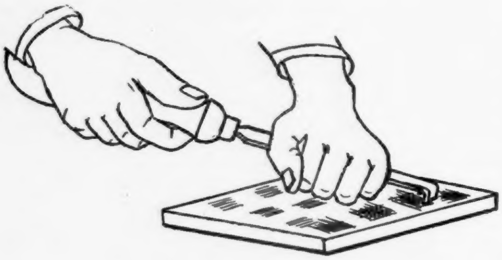


FIG. 30, USING THE SCRAPER

As far as the scrapers themselves are concerned, they may be made from old files in either of the shapes shown in the cuts. An old hand file drawn out wide and thin at the point, and then hardened, but not drawn, makes an excellent scraper. The cutting edges should be ground as nearly rectangular as is possible by hand grinding, but it will be found that the cutting edge, especially after whetting on an oilstone, is slightly convex. This will prevent the corners digging in, and will allow work to be done over very small areas.

The scraper is held and used as shown, removing the high spots indicated by the lead, Prussian blue, or other material. When the surface seems to be uniformly covered by these materials, both the work and the master plate should be wiped clean and dry, a little alcohol applied, and the bright clean spots will indicate the high places when considerable pressure is used. When rubbing the work over the master plate, care should be taken to work uniformly over its whole surface so that local wear will not destroy its accuracy. It will probably not be possible to get the whole of the surface to show contact with the plate. The process should be continued until the spots are quite numerous, of fair size, and evenly distributed. A favorite method of testing scraped surfaces on small pieces is to run the master plate on to them carefully and firmly, and then see if the work can be lifted by the master plate, due to the atmospheric pressure on the areas where the air is excluded. Of course, both surfaces should be absolutely clean and dry.

The method of originating a surface or master plate ought to prove of interest, not only on account of the process, but also on account of the logical reasoning involved. In order to get one plate, three must be made, and we will call them A, B, C. When all have been planed and filed as nearly as possible, C is laid aside and A and B both scraped until their surfaces coincide. Then B is laid aside, and C scraped to fit A, which is now used as a master plate. As B and C both fit A, they must be alike, but when tried one to the other it will be found that they are not plane surfaces. B and C must now be scraped until they show good contact, taking care to remove equal amounts from each. Then C is again laid aside, and A scraped to fit B. As A and C both fit B, they are identical and when placed together should show less error than did B and C. A and C are now each scraped equally to a true bearing. A laid aside and B scraped to fit C. This alternating process is to be carried on until any combination of two of the same plates show good contact over their entire areas. This result cannot be obtained with less than three plates, and more than that number are unnecessary.

The use of scraping for the purposes of finish need not be dwelt upon at any great length, for it is not considered good practice by the best tool makers. In some cases, however, it is an easy method of finishing surfaces and can be done in several geometrical designs by swinging the scraper on one corner as a pivot. Scraping which is extremely regular in appearance does not usually indicate a true surface, but a finished one.

Having reviewed at some length the production of surfaces by the use of hand tools, we naturally come to a consideration of means of fastening parts together and thus bringing these parts into their permanent relation. Screws, bolts, and pins are used for this purpose, and it is therefore necessary to drill holes.

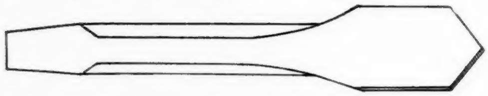
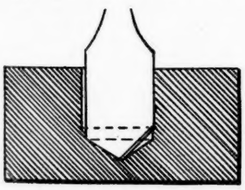


Fig. 31, Flat Drill

The drills used are of two general classes, flat and twist. The flat drill can be filed or forged from round stock, the point being made and hardened and drawn to a dark straw color. In most devices the drill is constantly turned in one direction, and the drill is made so as to cut only in that direction. Both cutting lips and also the sides of the drill have a small amount of clearance, that of the cutting lips being shown by the

Fig. 32, Twist Drill

angle of the short line across the point. Both cutting lips should have the same length, should form the same angle with the axis of the drill, and should have the same amount of clearance. In other words, the drill should be perfectly symmetrical. The included angle of the two cutting lips should be about 110°



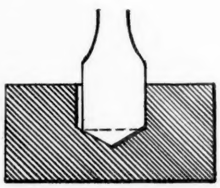


Fig. 33, Effect of Unequal Angles
Fig. 34, Effect of Unequal Cutting Lips

If the cutting lips form unequal angles with the axis, the lip forming the greater angle will do all the cutting and consequently dull rapidly, besides taking extra time. If the point is not in the centre, or if in other words, the lips are of unequal length, the hole will be made larger than the drill while the drill point is supported by the metal, and the same size as the drill, after the point has broken through. This explains why it is customary, when it is required to drill closely to the size, to first use a drill slightly smaller than the size desired, and follow it with one of

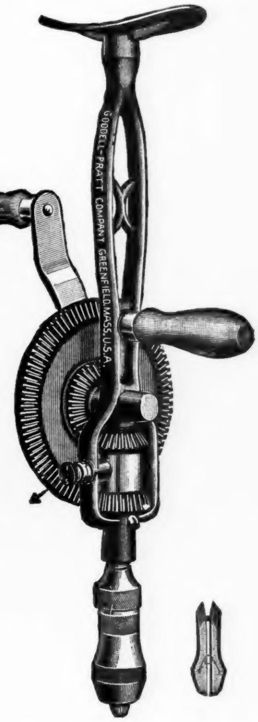


Fig. 35, Hand Drill Fig. 36, Breast Drill

the exact dimension.

It will be noticed that these flat drills, without regard to the care used in making them, must cut with a scraping action. Consequently they are not used where rapid work is necessary, and, due to the change of size in grinding, they cannot be used where large amount of duplicate work is required, They are cheap, quickly made of any size desired, and are used principally by the amateur and the experimental worker.

The twist drill has several important advantages over the flat drill. It is of uniform size throughout, removes metal by a cutting instead of a scraping action, and, due to the spiral form of the flutes, it tends to remove the chips from the hole

being drilled. They thus combine long life, rapidity of action. and uniformity of results. Twist drills are not easily made, and, although not very expensive, are not usually carried in complete sets. It is quite common to have the standard sizes of twist drills, and all the odd and special sizes of the flat form,

The flutes are of such a form that, to make the cutting edge a straight line, it is necessary to grind the drill to an included angle of 118_o. Accurate hand grinding of twist drllls is hard to acquire, as it requires a rolling motion not capable of close definition.

The common methods of using drills by hand include the fiddle-bow drill, the hand, and the breast drill, although the push drill used for small drilling in wood. can be used to good advantage with small drills in thin metal. The fiddle-bow works the drill back and forth and usually requires a special form of shank on the drill. While it can be held steadily, it is a time consumer, and is not much used at the present time except by the amateur. The hand and breast drills are so well shown by the cuts that no explanation seems necessary. The constant rotary motior. and the adjustable chuck are their points of advantage over the fiddle-bow.

Very little drilling is done by hand. A lathe or special drilling machine is much more rapid, and, where power could be obtained, would be used in preference to the hand methods. A chuck similar to the one used in the breast drill can be held in the head or tail spindle ol the lathe or in the spindle of a drilling machine, and the work rested on a tail stock drill pad in the lathe or on a table in the drill.

DIRECT READING VOLT OR AMMETER

FOR DIRECT OR ALTERNATING CURRENTS

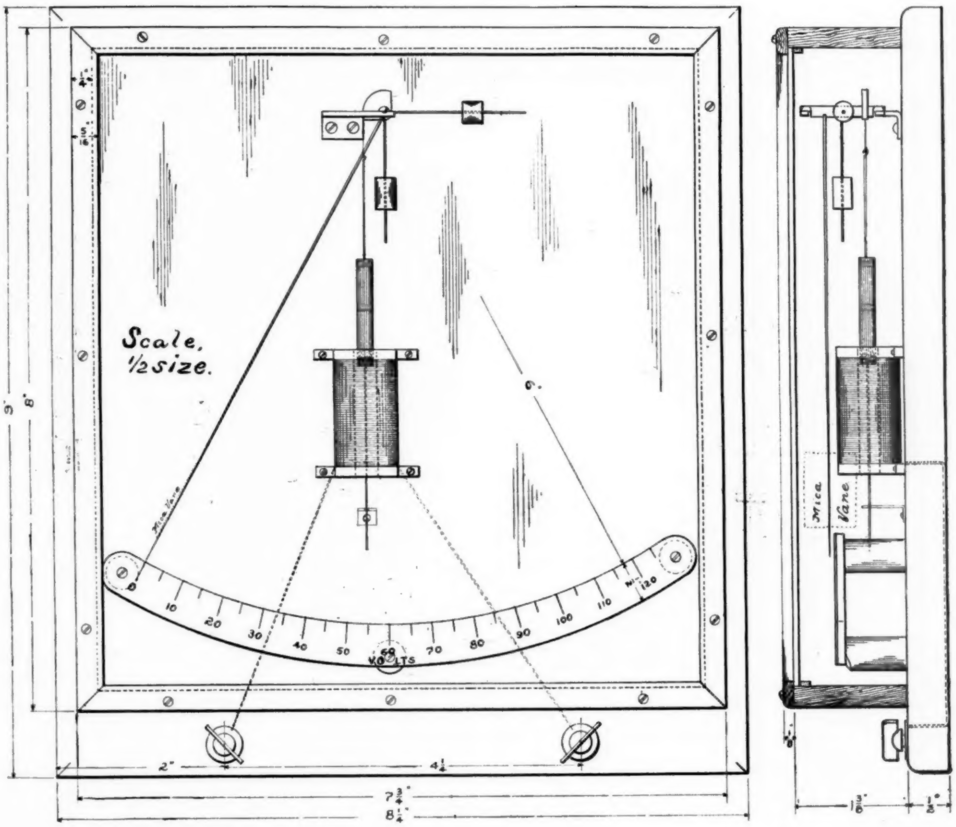
Robert Gibson Griswold.

The instruments described in the following article are exceedingly useful to the amateur possessing an experimental laboratory, as they will operate on either a direct or alternating current, in the latter case registering the mean effective value of the current rather than the highest instantaneous pressures, which vary from a maximum in one direction through a zero to a maximum in the opposite direction. The instruments are designed to be secured permanently in one position as in all switchboard types. While these instruments are extremely sensitive, they lend themselves to the easiest construction for the amateur.

A voltmeter to be of any great value must be sensitive enough to indicate small changes in current pressure. It must also be constant in its readings in order that dependence may be placed in them. The sensibility of a meter having a moving system depends upon a frictionless support, constant controlling force, and a system of small weight thus imposing but little inertia to be overcome in moving it.

Fig. 1 illustrates the plunger type of instrument in its simplest form, and one that may easily be constructed. Since the ammeter is to be exactly like the voltmeter with the exception of its coil, the amateur should make two of each part, the coils being described separately. The base and sides of the box should be of well seasoned mahogany that will not warp out of true, and the glass should be so fitted that it is practically dust proof. To support the glass from the under side, a small strip of cardboard may be glued to the sides, or they may be rabbeted, which of course makes the neater appearance.

The bracket *a*, Fig. 2, which supports the moving system, should be cut out of a piece of sheet steel about $\frac{1}{16}''$ thick and bent to shape. The small grooves *b*, are to be filed in with either a very small round file or one corner of a small square file. After cutting them to a depth of $\frac{1}{32}''$, polish them with fine emery or crocus cloth and oil until the surface is bright and free from scratches. Exercise great care to get these



grooves exactly in line. If the amateur possesses a lathe the grooves may best be ground true by holding the groove against a small brass wire held in the chuck and rapidly revolved, using a paste of emery flour and oil. This will ensure them being in line and the surface will be very smooth. Much of the sensibility of the instrument depends upon the fine finish of these grooves and the keenness of the knife edges resting in them. At the outer ends of the grooves a small piece of thin glass should be cemented to the bracket by a drop of shellac, care being taken that none of the shellac gets into the groove or on the surface of the glass where the rocker bears against it. The office of these pieces of glass is to prevent the rocker slipping endwise out of place, and being very hard and smooth they offer little resistance to the rotation of the rocker when they bear against it.

At *c*, Fig. 3, is shown greatly enlarged, one end of the rocker, illustrating how the knife edge is filed to a sharp angle and how the end is beveled so that when it does bear against the glass stop; it is merely a point that is in contact. This rocker should be made from a piece of ⅛″ drill rod or steel wire so that it may be hardened. Anneal it first by heating it to a cherry-red and allow it to cool slowly in ashes. After annealing, the holes for the small brass wires may be drilled at the relative angles shown, but if a very small drill cannot be obtained. a very good substitute may be made by winding the end of the wire around the bar once, and fastening in place by a drop of sol-

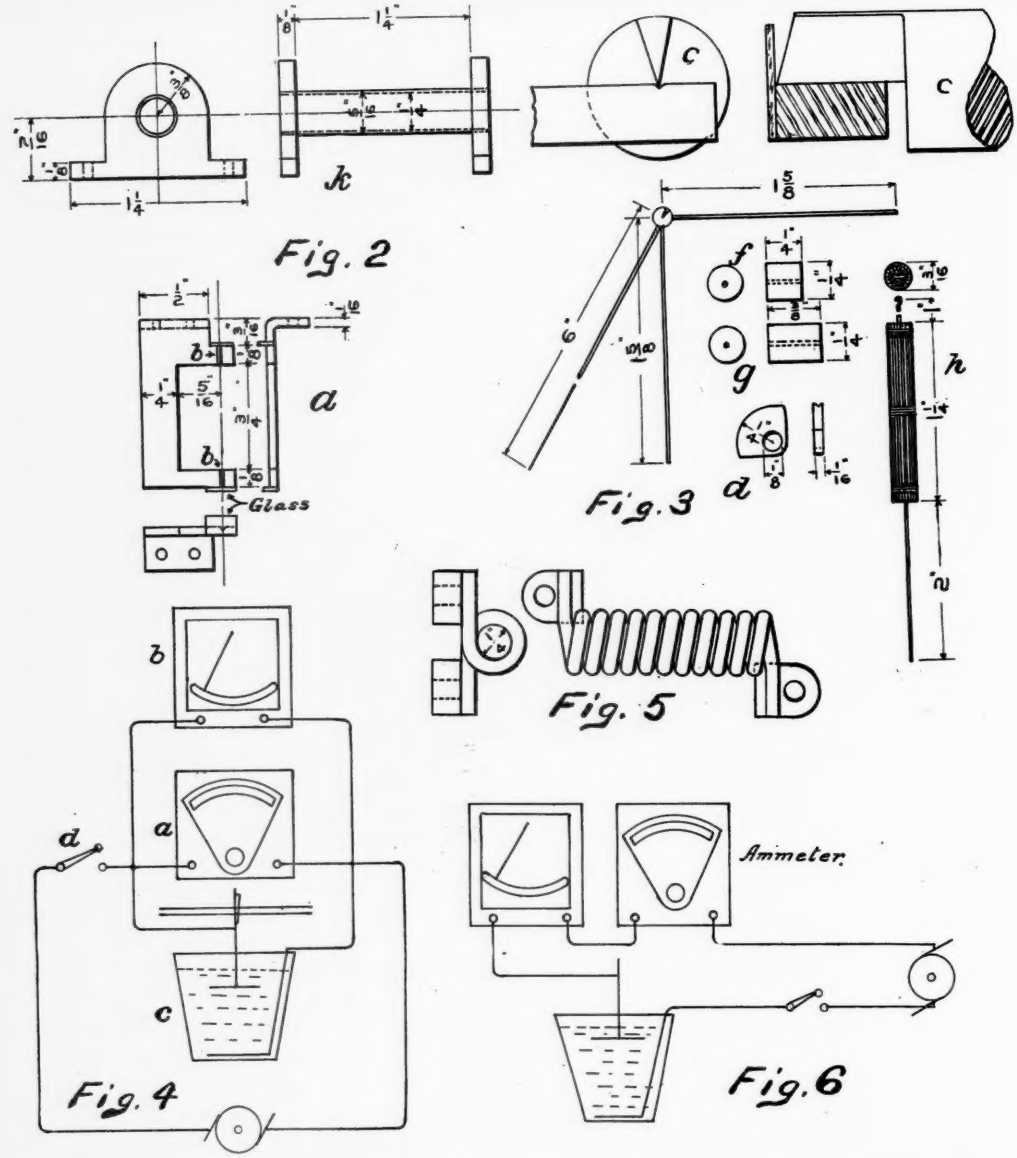


Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6

der. After the knife edges have been filed and the holes made for the wires, harden the piece by heating to a cherry-red and plunging into cold water. Then grind the knives to a sharp, keen edge on an oilstone, keeping them parallel and in line. The small brass quadrant *d*, may be slipped on and held in place by its own friction, the hole being made very little smaller than the bar so that it may be a drive fit. A small groove is filed in the circular edge of this quadrant in order that the suspending thread may be kept in place. The wires may now be riveted in the holes provided for them, or, if they are to be soldered, put them in place and melt a small drop of solder on them by means of a blowpipe flame, holding the knife edges in wet cloths to prevent having the temper

drawn. The rocker should be just a trifle shorter than the distance between the glass stops so that it will not bind.

The pointer or "spear" may be made of a piece of brass wire sharpened to a point at the extreme end, but a lighter one may be made by draw-filing a wire to a long slender point as shown. This is not a difficult operation if the wire is held on a piece of hard wood by a small clamp, the block being held in a vise. As the wire is filed to a taper on one side it may then be turned and the other sides so treated until a long slender point results, which may be finished with fine emery cloth. As a flux for soldering the brass wires to the steel rocker, use a drop of hydrochloric acid in which has been dissolved as much zinc as it will take. Carefully wipe off any surplus flux to prevent corrosion.

The wires upon which the small bobs are placed should be threaded, but if so small a tap and die is not at hand, a very good substitute may be had in the following method:—Drill a hole in the bob considerably larger than the wire and drive a piece of leather into it. Then drill a hole in the leather of such a size that the wire will just pass through it with some resistance. The bobs or weights may now be adjusted by giving them a twisting motion while pulling them in one direction or the other, and the friction of the leather will hold them securely in place. The knife edges should point in the same direction as the spear in order that when it has swung to the extremities of the scale the knife will not bind in the grooves.

The plunger is made of a bundle of fine soft iron wires, $1\frac{1}{4}''$ long, bound together by fine silk threads wrapped around them as shown, the whole being well impregnated with shellac and baked until dry, thus firmly cementing the whole together. The middle wire is made longer than the others, one end being bent into a hook to attach to the silk suspending thread and the other being polished so as to slip easily through the brass guide provided for it as shown in Fig. 1. The hole in this guide should be a little larger than the wire so that it will not bind, its purpose being to prevent swinging of the plunger.

The scale is cut from a piece of wood or sheet metal having a piece of white card-board glued to it upon which the divisions are marked in ink. The zero division is the only one that is marked on it when first made, the others being placed by calibration. Fasten it to the posts as shown.

The coil bobbin *k*, Fig. 2, has flanges made of wood, and the core shell, a hard paper tube made by wrapping a sheet of writing paper about a lead pencil, gluing each layer as it is wrapped on; it should then be cut to length, removed from the pencil and thoroughly dried. Glue the wood flanges on the ends and give the whole a good coat of shellac, allowing it to dry before winding on the wire. This bobbin on the voltmeter is to be wound full of No. 40, single silk covered magnet wire, each layer being thoroughly impregnated with shellac before another is wound on. The winding may best be accomplished by mounting the bobbin upon a shaft which can be turned by a crank made of wire, or in a lathe if one can be had. It will require about one ounce of the wire, and will have a resistance of about 1,700 ohms, consuming at 125 volts about .074 ampere. After the winding is complete, place the coil in an oven and bake for two days until the coil is perfectly dry and free from moisture in the inner coils. Do not raise the temperature too high or the shellac may be burned as well as the insulation.

The instrument may now be assembled. Secure the coil to the base by four small screws in such a position that the plunger will pass freely through it. Pass the wires from the coil through holes in the base, and along grooves in the back to two binding posts as shown. These posts may be readily made from brass screws by soldering pieces of flat brass in the slots. Solder the wire to a copper washer, fastening same to base with a drop of shellac. When the screw is in place, a wire is easily clamped between the under side of the screw head and the washer. Suspend the plunger from the brass quadrant by a fine silk thread, attaching it thereto by a drop of shellac. When the spear points to zero the plunger should just enter the coil. Now fasten the meter to the wall in the most desireable position, adjusting so that the plunger hangs perfectly free in the coil and guide. To make the spear read zero, adjust the smallest bob one way or the other until perfect coincidence is obtained.

As every voltmeter has its own constant and no two will read exactly alike although of similar

construction, it is necessary to calibrate each instrument by comparing it with some standard, especially when a sensitive form like the one just described is used for standard measurements. There are several methods of accurate calibration, but as they all require other standard instruments, the writer would suggest that the amateur secure the loan of a good voltmeter, such as the Weston, and calibrate his instrument in the following manner.

Connect the two in parallel with a rheostat of some form, and a switch in series with the source of current, as shown in Fig. 4. The water rheostat is the simplest and easiest to construct. To a small copper disk, fastened to the bottom of a wooden bucket, solder one wire leading from the source of current as shown, insulating it where it passes through the water by means of a glass or rubber tube. To a similar disk attach the other wire, so arranging the apparatus that the upper one may be adjusted to any distance from the plate on the bottom, thus varying the resistance. Fill the bucket with water very slightly acidulated with sulphuric acid.

As the maximum capacity of the meter is 125 volts, adjust the disks in the bucket so that the Weston meter reads 125 volts. The spear on the instrument to be calibrated will now swing to some position on the scale, but the largest bob should be put in such a position that the spear will point to a line near the other extremity (unmarked) of the scale. Mark this position with a lead pencil. Now gradually reduce the resistance at *c*, marking on the scale of *b*, the positions corresponding to 120, 110, 100, 90 etc., volts as indicated by the meter *a*. When the ten divisions have been thus marked, the scale of *b* may be removed and these position marked in ink, also drawing in the intermediate fractional divisions. Now reverse the connections of *b*, and recheck as above to determine whether the instrument will read alike with the current flowing in either direction, which it should do. If not, it is probably due to a slight permanent magnetization having been acquired by the plunger. The only remedy is to replace it with one of softer iron wire. This test is to determine its adaptability to alternating currents, as the direction of flow in this case is constantly changing.

The glass front may now be secured in place as the instrument should be protected from draughts of air and dust as it is extremely sensitive. If the full current is to be switched on suddenly, it will result in a violent swing of the spear to the extremity of the scale. To prevent this, attach a light sheet of mica to the spear with a drop of shellac, which, owing to the resistance offered by the air will cause the movement to be smoother.

The only difference between the voltmeter and the ammeter is in the coil, that of the latter being made of eleven turns of No. 10 bare copper wire, as shown in Fig. 5, ends of which are soldered to small brass blocks to afford a hold for the screws. This coil should be placed in the same position as that of fine wire in the voltmeter, the same care being exercised in its adjustment. The wires leading from the binding posts must be of the same size or slightly larger if possible, as they must carry the entire current passing over the line. The binding posts must in this case be large to prevent heating, and it is suggested that if possible the amateur purchase these from some electrical supply house. Instead of passing the wires down through the base, and along grooves in the back, they may be continuations of the wire in the coil, and pass directly out through the sides, the holes where they pass through the box being insulated with a short piece of glass tube that will take the wire in its bore. It is well to caution the amateur at this point with regard to heating. This coil is designed to carry 18 ampers with a rise of 20° above normal temperature. To avoid any risk from overheating, which might set fire to the wood base, place a sheet of asbestos paper under the coil before it is secured in place. Too great emphasis cannot be placed upon proper insulation, and every precaution should be taken in this direction. If the amateur can secure a sheet of fibre, recess the base to receive it and mount the coil upon it as well as the binding screws.

The calibration of this ammeter is effected in the same manner as that of the voltmeter, but the connections are shown in Fig. 6, using an ammeter instead of the voltmeter. Should the instrument not be required to measure as high as 18 amperes, adjust the spear to run to the end of the scale for whatever maximum value is required. The voltmeter may also be calibrated to lower values.

STUDIES IN ELECTRICITY

XVIII. INDUCTOR ALTERNATORS

The dynamo electric machines which have been described in previous chapters, although differing in detail, all have one common feature, coils of wire rotating in a magnetic field. That is, a moving conductor cuts the lines of force and so generates E. M. F. In these machines the field magnets are stationary, and the armature coils rotate, or the armature is stationary and the field magnets rotate.

There is another class of machines in which both armature coils and field magnets are stationary, the cutting of the lines of force by the armature being obtained by moving masses of iron called *inductors*, in such a way as to alternately secure a very good and then a very bad magnetic circuit through the armature and field magnet coils. This type of machines, called *inductor alternators* posseses important advantages, being mechanically simple in construction; easy to connect with the external circuit, as collecting rings are not necessary; perfect insulation is easily obtained, and but little attention is needed in operation. Fig. 39, shows one design of such an alternator, the armature *A*, being fixed and placed outside the field magnet; the field magnet is magnetized by a coil *C*, which is also fixed, so that no brushes or sliding contact is required for connections with armature or field magnet coil, the moving part consisting solely of the magnet *M*, made up of soft iron laminations and a supporting spider.

The outer frame work of the armature is of cast-iron, holding in position the laminated armature core *A*, consisting of a large number of thin, soft iron sheets, projecting inwards and insulated from each other. These core plates are continuous around the armature, being slotted at points on the inner circumference to receive the armature coil, *C*. These core plates are not solid through the armature, but are in two sections, each occupying about one third of the cross section, leaving a space of about the same section between them, but connected together magnetically by the iron frame-work.

The armature coils, *C*, are connected in series, and very carefully insulated from the core plates. The field magnet, *M*, and *M'* consists of two eight armed spiders of cast mild steel, mounted on a shaft, and separated from each other by a layer of non-magnetic material. Each section is so placed on the shaft that the arms will be staggered; that is, an arm on one section will be central be-

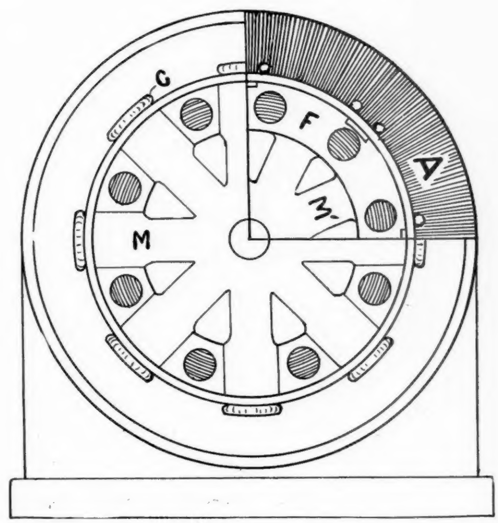


Fig. 39.

tween two of the opposite section, one section being the N poles and the other the S poles. Each arm constitutes a pole piece of the field magnet, the end of each arm consisting of thin, soft iron laminations insulated from each other and rigidly clamped in position. This construction prevents the formation of eddy currents.

The field magnet coil, *F*, is wound in two sections on a brass form provided with holes to facilitate ventilation.

Each section is separated by an air space to secure a free circulation of air, which is increased by the motion of the magnet arms. The coil frame is supported by brackets at several points,

and occupies a central position between the revolving field magnet with its pole pieces, and the armature core plates and coils.

In operation, when the pole pieces of south polarity are immediately under the armature coils, those of north polarity, on the other side of the field magnet, are midway between coils. In this position, lines of force pass upward from the north pole of the field magnet into those parts of the armature core not encircled by wire, across the cast-iron frame-work, thence downward through the armature coils into the south poles of the field magnet. When the field magnet has revolved so that the north poles are directly under the coils, the lines of force pass in the reverse direction, and this constant reversal continues as the field magnet is revolved. Although this reversal of the lines of force takes place through the armature coils, they are not reversed through the armature core or any part of the iron, as the poles passing any part of the core are always of the same polarity, and the lines of force simply rise and fall through the iron.

The air gap between pole pieces and the core is very small, and as the induction of the field magnets is not high, the leakage is reduced to a mimimum. This small air gap would also have a tendency to allow the lines of force set up by the current in the armature to pass more readily into the field magnets, and thus oppose those of the field, reducing the E. M. F. developed, were it not for the small air gap, previously mentioned, between the two sections of the magnet frame, which increases the resistance of the magnetic circuit and deminishes the reaction of the armature.

PROJECTION

CARL H. CLARK

VII. CIRCLES AND CYLINDERS.

Plate 24, Fig. 1, is the plan and elevation of a circle; the elevation showing the full circle and the plan nearly a straight line. As there are no corners to project from, as in polygons, divide the circumference into any number of equal parts at *a-b-c-d* and drop perpendiculars cutting the plan at *A. B. C.*

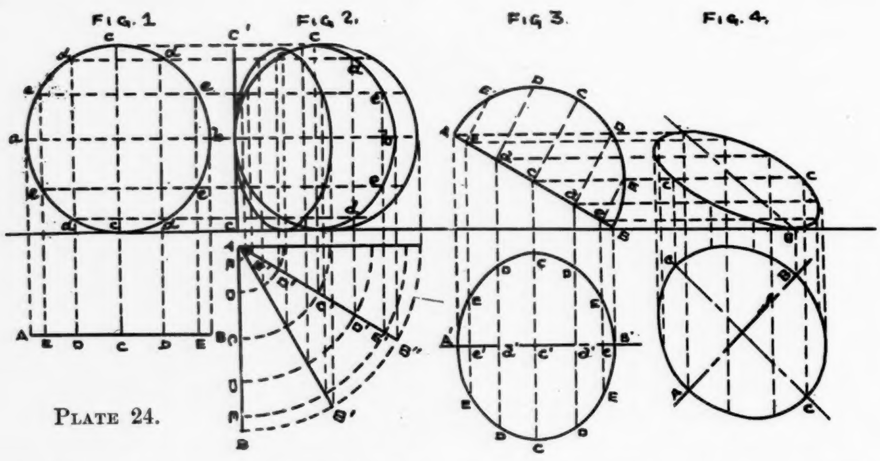


PLATE 24.

Fig. 2, shows the same circle when standing at right angles to both verticle and horizontal planes, both projections being straight lines, *A*, *B*, *ana* *C.C.* The points *A*, *B*, *C*, etc., being the same as in Fig. 1.

To find the elevations when the plane of the circle has been turned about *A* to an angle of

about 30° to the vertical plane, draw the line *A-B″* at 30°. Now during the rotation all the points remain at constant distances from *A*, so that this new position is found by swinging arcs from each point with *A* as a centre. Bearing in mind that their heights above the horizontal plane do not change, horizontals are drawn from the points in the elevation and are cut by verticals carried up from the new plan. These intersections are points on the new elevation, *a*, *b*, *c*, *d*, *e*, while points are now to be connected by a curve drawn through them.

The ine *A-B′* is at 60° to the vertical plane, and the elevation above is obtained in the same manner.

show the relative position of these points along the axis *A-B*, which is really the point desired. Now in the desired position draw *A′*, *B′*, parallel to the intersecting line and cut it by perpendiculars from the points above, giving *e′*, *d′*, *c′*, *d′ e′*. Draw lines through these points perpendicular to *A′-B′*, and lay off *e′-E*, equal to *e-E* in the elevation, *d′-D* equal to *d′-D*, and so on. The reason for this being that since *A′-B′* is parallel to the vertical plane these distances appear in their true length and are equal to those in the semicircle above. The outline is then to be drawn through these points.

To obtain the projection after a further rotation of its diameter to an angle of 45° with the

PLATE 25.

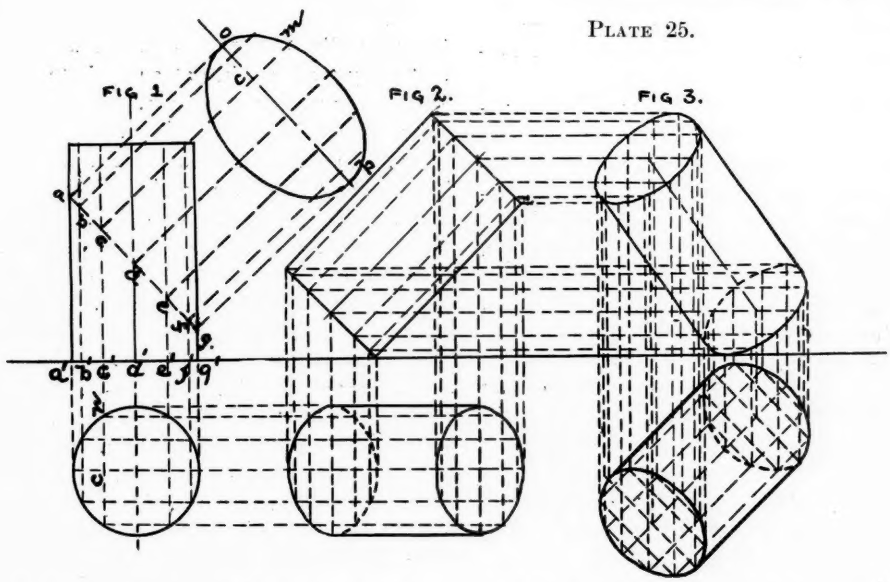


Fig. 3, shows a short method of obtaining these projections, and as the circle is the most common of the geometrical figures used in mechanical work, the method will be described.

The elevation is determined by drawing a line *A-B*, at the required angle to the intersecting line and laying off on it a distance equal to the diameter of the circle. On this diameter describe the semicircle *A*, *E*, *D*, *C*, *D*, *E*, *B*, and divide into the usual number of parts. Through these points draw lines perpendicular to *A-B*, cutting it at *e*, *d*, *c*, *d*, *e*. It is evident that these last

verticle plane, Fig. 4, the plan is a reproduction of that of Fig. 3, with its diameter making the 45° angle. The rest of the work is the same as the projection of polygons, projecting lines being carried across from elevation Fig. 3, and cut by verticals drawn through corresponding points in the new plan, and a smooth curve drawn through these intersections.

The curve obtained in these projections is that known as the ellipse and it is always seen when a circle is viewed, otherwise than at right angles.

CONTINUED ON PAGE 134

AMATEUR WORK

63 KILBY ST., BOSTON

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APRIL 1903.

As many readers of this magazine have undoubtedly made one or more useful and interesting articles, a description of which would be welcomed by other readers, the following prizes are offered for the purpose of securing such descriptions. By this means we hope to obtain descriptions of interest and value, and make valuable to the many, that which is now known to but a few.

PRIZE No. 1. $10,00 For the best description of a piece of furniture, the making of which requires only hand tools commonly possessed by the average amateur.

PRIZE No. 2. $10,00 For the best description of an electrical instrument, or device, the making of which requires no more machine work than could be obtained at an expense not exceeding $1,00.

PRIZE No. 3. $5,00 For the best description of any article suitable for the Junior Department.

All articles intended for this competion must be mailed and show a postmark not later than May 31, 1903. Articles which may not secure a prize and yet be of interest, will be accepted at our regular rates, and published as occasion presents. Drawings, photographs, or other illustrations necessary to a proper presentation of the subject must accompany all articles. Drawings must be made on smooth white paper or cardboard, in India ink. Descriptions should be tyepwritten if possible, using only one side of the paper with liberal margins. No name should be signed to a description, the name and address of sender being given on a separate sheet enclosed with the article.

PROJECTION. CONT'D.

A cylinder may be considered to be a prism whose ends are circles, and the other definations given in regard to prisms apply equally well to cylinders.

Fig. 1, Plate 25, represents a circular cylinder standing on its base. In Fig. 2, the cylinder is tipped so that its axis is at 45° to the horizontal, and in Fig. 3, it has been rotated horizontally till its axes is 45° to the vertical plane, The method of obtaining these projections is the same as has already been used in describing the projection of prisms and is left to be worked out by the student. The prism shown was 4″ high and 2″ in diameter.

It is evident that every section of a cylinder taken parallel to the faces will be a circle, and that every section taken at an angle to the plane of the faces will be an ellipse. Such a section is shown by the line *a-d-g*, Fig. 1, and the sections above. To obtain this true section the line *a-g*, is drawn at the proper angle cutting the projection lines in the points *a-b-c*, etc. Now from these intersections, lines are drawn perpendicular to *a-g*, and a line *o-p*, parallel to *a-g*, to serve as a centre line for the development. To find any point on the development as *m*, take from the plane the distance *c-n*, and lay it off on each side of the centre line *o-p*, giving *c-m*. The other points are obtained in the same manner, and a smooth curve drawn through them.

It is plain that the development of the surface of the cylinder is a rectangle whose height is equal to that of the prism and whose length is equal to the circumference of the circle forming the base. To develop the surface if the portion above, *a-g*, were supposed to be taken away, lay off a line equal to the circumference of the base as before, and divide into the same number of equal parts as are used in the projection. Erect perpendiculars at these points, and upon them lay off the distances *a-a′*, *b-b′*, *c-c′*, etc., on the proper lines, and draw a curve through these points.

It is recommended that the student, after completing the constructions outline above, attempt the projection and development of an "elbow" or right angle bend, formed by two cylinders at right angles to each other.

WOOD TURNING FOR AMATEURS.

F. W. Putnam, Instructor Manual Training School, Lowell, Mass.

VII. HANDLES.

Tool handles of various kinds may be bought at a very slight expense and they serve as excellent models for the amateur to use for practice. Even the expert wood-turner may find himself so situated that he can more readily produce them, or he may prefer to turn his own tool handles.

Short turned tool handles range from about five to eight inches in length, and the material, whether of hard or soft wood, is usually cut square by the saw, of just sufficient size to allow the block to be readily turned down to the largest diameter. The stock to be used may be any kind of hard wood that does not spilt easily when driven on the head centre. Hickory, birch, elm, or ash make very good handles. Ash is perhaps the best, as it does not blister the hands.

The sketches given in Figs. 60 to 64, have been drawn to scale and the dimensions carefully given, so that the amateur may have all necessary data to work from.

The various models shown in these sketches will be found to be in good proportion, the curves pleasing to the eye, and have been used by the author with good success during the past four years.

Chisel Handles.

Fig. 60 shows three sizes of handles for socket firmer carpenters' chisels. The smallest handle, *a*, is used for chisels from $\frac{1}{8}''$ up to $\frac{5}{8}''$; the medium sized handle *b*, for chisels from $\frac{5}{8}''$ to 1″, and the largest handle *c*, for chisels from 1″ up to 2″.

When it is necessary to turn a large number of such handles, a "templet" is often used to avoid the necessity of frequent adjustment of the measuring tools. This templet may be made from a piece of sheet-iron, zinc, or wood. If wood is used, steel wire brads should be driven into the edge of the templet to give the principal dimensions for length. These brads should not project more than $\frac{1}{8}''$, the heads being cut off and the end of the brads filed to a point. When this edge of the templet is brought up against the revolving block, lines will be marked by the points of the brads. The caliper sizes to correspond to each diminsion for length should be cut out of the opposite side of the templet. If metal is used for the templet, the principal dimensions for length should be notched on one side with an iron file, the caliper sizes to correspond being cut out on the opposite edge, just as in the case of the wood templet.

Turning the Handle.

Care should be taken not to split the block when driving it on the head centre. First turn the stock with the large gouge to a trifle over the largest diameter given by the largest opening in the templet. Next hold the notched edge of the templet against it marking lines along the block corresponding to the various notches on the edge of the templet. With the parting tool cut grooves into the wood at these points. The diameter at the depth of each groove is to be determined by the templet, using, of course, the opening that corresponds to the notch where the groove had been made by the parting tool.

When all the grooves have been cut to the proper depth, the gouge is to be used to reduce the block to the required outline, as shown in the figure. With the practice gained in the use of the gouge in turning concave and convex curves as described in the previous chapter, the amateur should be able to approximate very closely the required curves with the gouge alone. The skew chisel may be used for finishing the curved end of the handle and all straight parts. Care must be taken, in finishing up the tapered end of the handle, to work accurately to the measurements given. The handle before being finished, should be taken from the lathe and tried in the socket of the chisel, to make sure of the proper size.

The handle is to be driven into the socket, and $\frac{1}{4}''$ should be left for driving, so that when the

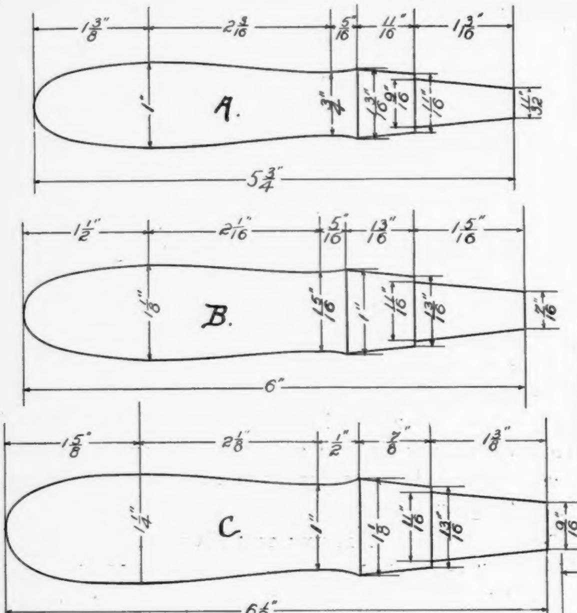


Fig. 60

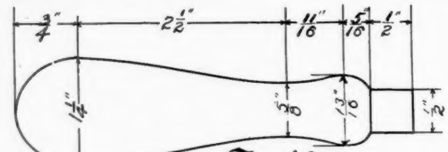


Fig. 62

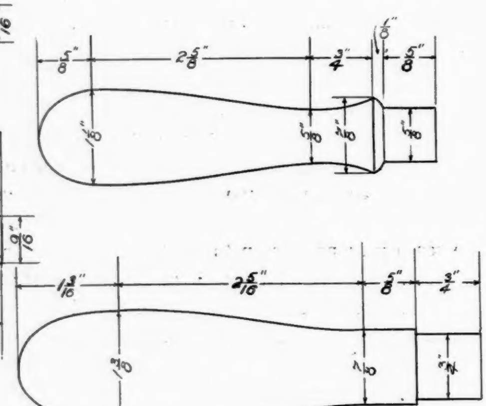


Fig. 63

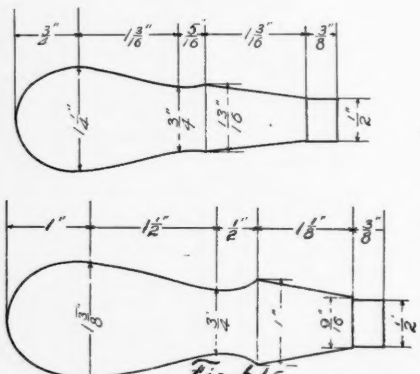


Fig. 61

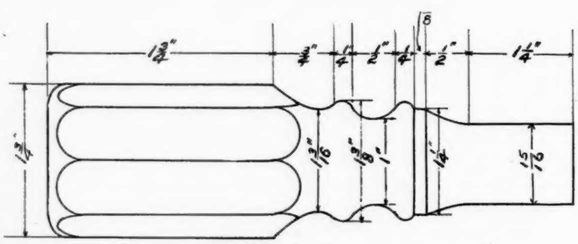


Fig. 64

handle is forced into the socket with the hands it should fit tightly with $\frac{1}{4}''$ left between the end of the socket and the shoulder on the tapered end of the handle.

After the handle has been turned to the desired form, it should be sandpapered with No. 0 sandpaper. The tee rest should be removed so as to give more freedom to the hands in holding the sandpaper against the revolving handle. Care must be taken in sandpapering, not to get the fillets rounded, or the beads blunt. It is a good plan to take a small piece of wood, with straight edges at right angles to each other, wrap round it a piece of fine sandpaper, and hold it square on the fillets, turning it over on the bead, thus leaving the fillets clean and sharp.

When thoroughly sandpapered, put on a coat of raw linseed oil with a cloth. The handle can be polished by rubbing it with a cloth while the lathe is running, or a coat of shellac varnish may be added.

The shellac varnish is made from either yellow or white gum shellac, the latter being more expensive. Gum shellac may be dissolved either in

wood alcohol or in grain alcohol. The grade of shellac used should be good, as it is not economy to buy cheap material for this purpose, on account of the fact that it will not "stand up to the work" as long as a better grade. Care should be taken not to use mixed wood and grain alcohol with shellac, as it will form a varnish that does not dry quickly and is more easily affected by moisture.

If the shellac varnish is used, apply a thin coat with a brush. The handle should then be put away to dry. After an hour or two, when the varnish has become hardened, it will be necessary to very lightly sandpaper the handle to remove the small particles of wood which have "risen" from the surface. Having wiped the surface clean with a piece of cotton waste, apply a second coat of the shellac varnish. This coat when dry should be rubbed down with a little pumice stone and oil. When the handle has been polished satisfactorily, the ends by which the handle was held in the lathe are to be cut off.

A second method of finishing tool handles is as follows:—Apply two coats of raw linseed oil with a cloth, while the lathe is running. When the oil has dried thoroughly, apply oil and shellac together on a cloth to the revolving surface. The oil will prevent the shellac from sticking to the surface of the handle. If the cloth be held up against the revolving handle there will be friction enough resulting to give a very fair polish.

Screw Driver Handles

Fig. 61 and Fig. 64, represent three sizes of screw driver handles, the latter being an octagonal handle a 16″ screw driver. The wood used for handles with brass ferrules must be well seasoned, or the ferrule will drop off.

The block is to be turned first to the largest diaemter, as shown either by the templet or the caliper. The end to receive the brass ferrule is finished first. This end is often spoken of as the *pin*. A surface incision is made to form a square shoulder at a sufficient distance from the end to the square edge of the ferrule. If a brass tube is used for making the ferrules, as described in the last chapter, the pin should be turned only slightly tapering from the shoulder down to the edge of the handle.

Polished brass ferrules can be bought at almost any hardware store, and are in general use because they are somewhat heavier than those gengrally made from common brass tubing.

These ferrules have a decided taper on the inside, so that the pin end must taper at least $\frac{3}{32}$″ if this style is used. Gauge the interior diameter of the ferrule with a pair of inside calipers, and turn the pin end down so that the ferrule may be slipped part way on with the hands. The ferrule must fit very tightly against the shoulder at the end of the pin.

To "drive it home", a second ferrule should be placed over the first and struck with a mallet, or the handle with the two ferrules may be placed between the jaws of an iron vise, and the ferrule forced up to the shoulder by the closing of the vise. The second ferrule is necessary because the wood should project out about $\frac{1}{8}$″ beyond the first ferrule, this extra stock being cut away after the hole has been drilled in the handle to receive the tang of the tool.

The work is then returned to the lathe, and the handle finished with the gouge and the skew chisel, the parting tool having first been used to approximate the principal diameters as explained above in the turning of the chisel handles. If no templet is used, use the calipers freely. It is more than likely that, at first, the convex curve will be turned flatter than was intended, but this may be avoided to a large extent by turning the form very carefully with the gouge, the final shaving being taken with the skew chisel.

When making a large number of such handles, every one is first turned down to the largest diameter with the gouge, and the pin end turned to the size of the ferrule, all are then driven or forced into the ferrules. The handles are then replaced in the lathe, and the parting tool, gouge and skew chisel consecutively used on each. The next thing required for the finished handle is to strike a deep centre punch mark on either side of the ferrule to prevent its loosening from possible shrinkage of the wood. The ferrule end should be supported in an angular notch cut in the end of the grain of a piece of oak or hickory and held in a vise. The handles must next have a hole drilled in the ferrule end to receive the tang end of the screw driver. There are several ways in which this

may be done. If a small upright power drill is available, the hole can be drilled without the slightest trouble. If the lathe is equipped with a two jawed adjustable tool chuck, the chuck holding the drill should be placed in the head spindle in place of the head centre, and the handle held against the tail spindle. The lathe should be run at its slowest speed, and the tail stock clamped tightly in place, the hole being bored by the turning of the hand wheel on the tail stock, thus forcing the handle against the revolving bit or drill· If a carpenter's stock and auger bit are used, care must be taken to bore straight.

This rounded hole must subsequently be enlarged to fit the taper tang of the tool. One of the simplest methods of doing this is to heat a pointed iron rod and burn the hole out to the desired size.

The large screw driver handle shown in Fig. 64 is left square on the end until the ferrule has been fitted and the remainder of the handle turned to the desired size. The handle is then taken from the lathe, placed in a vise, and the corners taken off with the carpenter's smoother plane. This is an eight sided handle, consequently the angle between each surface will be 135°. If the T-bevel or bevel square be set at this angle it will greatly aid in the testing of the planing.

Fig. 62 shows a handle for the $\frac{1}{4}''$ special round nose turning tool shown at D. Fig. 10

Fig. 62 shows two sizes of file handles. With the directions that have been given, the amateur should have no difficulty in turning and finishing any of these handles.

Face Plate Work.

The work up to this point has made use of stock, the grain of which has been parallel with the axis of rotation of the lathe. It is often convenient and frequently necessary to turn the cylunder "plankways", that is, with the grain, at right angles to the axis. The stock is necessarily always cut from blank, hence the term plankways Blocks in which the grain is at right angles to the axis of the lathe are generally held by centre screws which are attached to a face plate as shown in Fig. 65. This plate is generally called the Screw-plate although sometimes it is spoken of as the Screw Centre.

Frequently the block is secured to the face plate by short screws; this kind of a face plate was shown in Fig. 9. One of these two face plates is always used when a block is to be wholly supported from one end, in which case the tail stock is pushed back to the end of the bed. The thread of the face plate should be kept free from dirt and should be given a few drops of oil as it is screwed on the end of the head spindle. Unless this is done, and the plate is screwed on tightly, it will be very apt to "jam" and so be difficult to remove. In turning the surface of soft wood plankways, the tee of

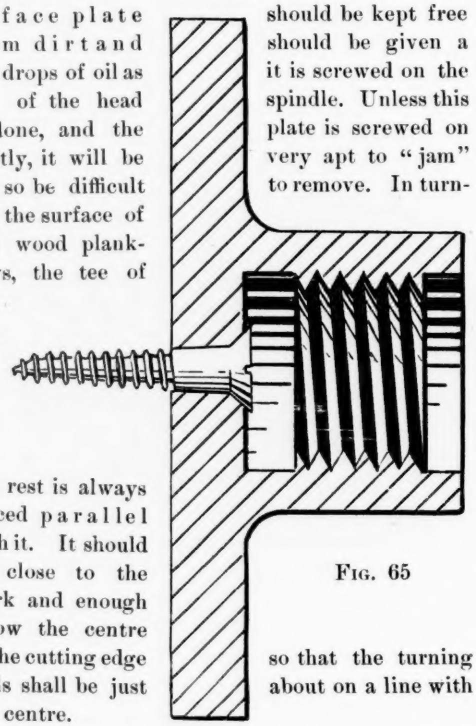


Fig. 65

the rest is always placed parallel with it. It should be close to the work and enough below the centre so that the turning of the cutting edge about on a line with tools shall be just the centre.

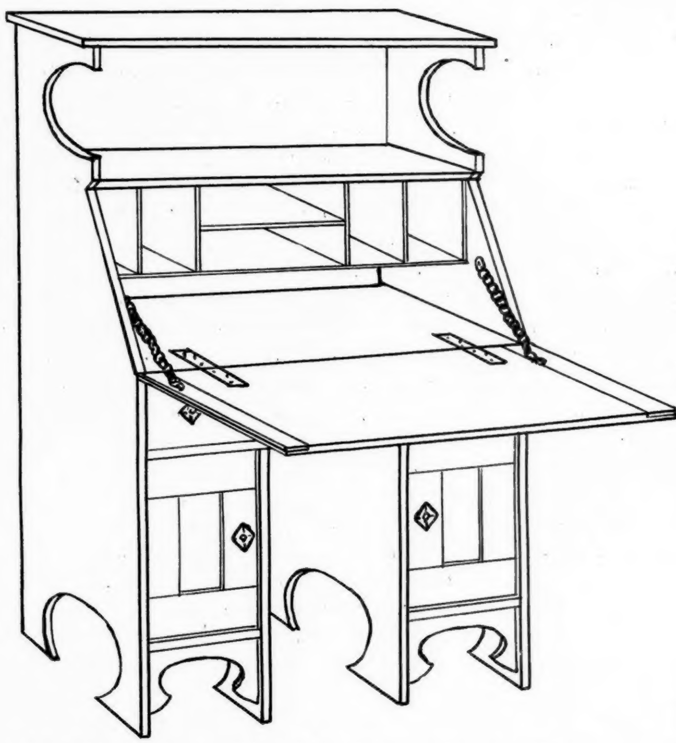
The block to be turned should always have one surface planed up "true". This surface, which is to come against the face plate, should first be marked with the compasses to a circle about $\frac{3}{16}''$ larger in diameter than the finished work. If a band saw or turn saw is convenient, the block may be cut down to this circle; otherwise the corners of the block are to be cut off with a hand saw, reducing it to a rough octagon. The block is then fastened by wood screws to the face plate with the centre of the block over the centre of the face plate.

The next article will take up in detail the turning of a bread board and a picture or mirror frame.

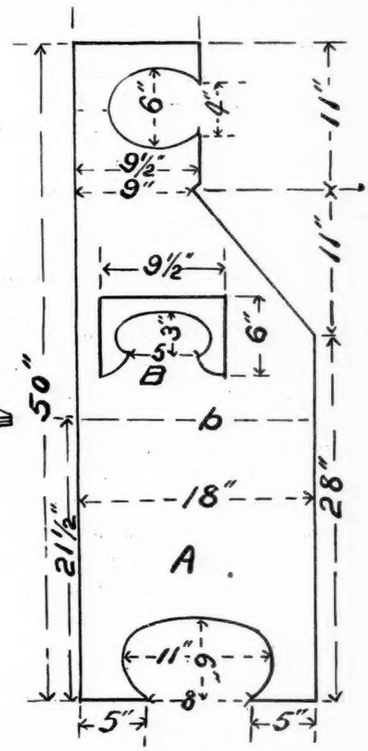
A WRITING DESK

JOHN F. ADAMS.

This desk will be found by anyone who makes it, a very convenient one and easily constructed. It should be made of selected oak 7-8″ thick, except where some other thickness is specified, and stained a very dark brown or black with a dull finish. The trimmings should be black iron, if obtainable, or brass. The shape of the sides *A*, with dimensions, is shown in the illustration. The sides of the leg-well are of the same shape as the lower part of the sides, their length being indicated by the dotted line, *b*, In width they are ½″ narrower, this being taken from the back edges to allow room for backing. These pieces will probably have to be glued up, care being taken to so match the grain as to get a good appearance. A ½″ rabbet, ½″ deep, is cut in the inner back edges of side pieces for the backing.



The circular openings at top and bottom can be cut out at the lumber mill at little expence, if drawings are made on heavy paper, cut out and carried to the mill when ordering the stock. The shape of the small pieces under the doors, is shown at *B*, patterns also being made for these.



The top shelf is 32″ long, 10 ½″ wide, and ⅞″ thick. It is fastened to the sides by three 2″ screws at each end, the heads being countersunk. Bore holes for the screws to avoid splitting the top ends of sides. A ½″ rabbet is cut on the under back side to receive the ends of the back sheathing.

The shelf forming the top of the writing compartment of desk, is 28 ⅛″ long, 9″ wide on upper side, 8 ½″ on lower side, and ⅞″ thick. The front edge is beveled as shown to fit the up-

per edge of the lid. The writing board is 28 ¼″ long, 17 ½″ wide, and ¾″ thick. This board and the shelf are fastened to the side with several 2″ screws put through from the outside, holes for them being drilled and contersunk. A drawer reaching clear across the desk, but only partially shown, comes directly under the writing board. The drawer is 28 ¼″ long, 16″ wide, and 5″ deep. It is supported on a frame made of ⅞″ strips, and measures 28 ¼″ long, and 17 ½″ wide, the front and back pieces being 3″ wide, and the ends 2″ wide. The joints are mortised, ¾″ or 1″ tenons being long enough, as they should be set up with glue. The upper surface must be true as the ends form the runs for the drawer. Fasten the frame to the sides with screws as before mentioned. After having attached the top end of the sides of the leg-well, these being placed 9 ½″ from the ends of the frame.

The pieces forming the bottom of the cupboards are 9 ½″ wide, and 17 ½″ long. The preferable way to make up these pieces is to cut a ½″ rabbet in a strip 9 ½″ long, and 3″ wide, forming the front end, and glue it to a piece 15″ long, and 9 ½″ wide, on one end of which a ½″ rabbet has been cut to match the other piece. By doing this, the grain of the wood on the front end will be as desired. These pieces are also fastened to the sides with screws, so that their under sides will be 7 ⅝″ from the floor. The pieces under the doors are now put in, holes for screws being bored at an angle on the inner side, thus concealing them and avoiding boring into the sides.

The doors for the cupboards are made of ¾″ stock, the panels being ¼″ long, and 3″ wide; the vertical pieces being 13″ long, and 2 ½″. The joints are halved, and a rabbet cut on the inner edges for the panel. The piece for front of drawer is 28 ¼″ long, 5″ wide, and ¾″ thick, a ½″ rabbet being cut in the sides to receive side pieces, and on the lower edge for the bottom board. The side pieces are 16″ long, 5″ wide, and ½″ thick, white wood being suitable. The back is also of ½″ white wood, 26 ½″ long, and 5″ wide. The back ends of the sides pieces have a ⅛″ rabbet cut in them to receive the ends of the back piece. A narrow rabbet is cut on the lower edge of side and back pieces for the bottom board. See that the drawer is square, and set up the joints with glue.

The pigeon holes are made of ⅛″ maple, birch, or white wood as preferred. This is all framed up, and when complete, put into position and fastened with screws to top and back. The top piece (not shown) and bottom piece are 28 ¼″ long, and 8″ wide. Six upright pieces cut from same stock, 4″ wide, (with the grain) are nailed so as to form pockets 4″ wide. The piece dividing the centre space is 10 ¾″ long and 8″ wide, and should be nailed to the centres of the two upright pieces before these are nailed in position.

The drop lid is 31″ long, and 14 ½″ wide, and made of a single piece of clear grained oak, ¾″ thick, if it can be obtained. This allows it to extend ½″ on either side. If it is preferred to have it flush with the sides, it should be 30″ long.

The inner edges of the ends are halved and strips 14 ½″ long, 3″ wide, and ⅜″ thick, are carefully fitted and will glued thereto, serving to prevent warping or cracking. The lid is attached by two desk hinges, and supported at the ends by suitable chairs. Ornamental hinges or ornaments may also be put on the doors of the cupboards,

The back of the desk is made of ½″ matched sheathing. A piece of oak 10″ long, 4″ wide, and ¾″ thick, with a ½″ rabbet cut on the upper back edge is fitted across the back of the leg-well, the rabbet being in line with the under sides of the floors of the cupboards. To this piece is attached the sheathing at the back of the legwell. The upper ends of sheathing are screwed to the rabbet in the top piece previously mentioned, and also to the other cross pieces at several points to secure strength. The doors to the cupboards are set in about ¼″, but the hinges will have to extend outward sufficiently to enable the doors to swing wide open.

In a recent consular report from Ranbaix, mention is made of some interesting experiments with silkworms which have resulted, it is said, in the production of cocoons of varied shades. The food of the silk worms was colored with some simple coloring fluid. In one instance, where the leaves fed the worms were dyed red, when the larvæ began to spin, the silk was a bright red.

A CANVAS PADDLING CANOE

By "Nautilus"

A canvas canoe is easily built, and if proper care and time be taken in the construction, will be found very satisfactory to the owner. As often built, however, they are very cranky and soon lose form; faults which any boat should not possess. Frequently canoe troubles can be directly traced to the haste and way in which a canoe was built, usually with the first canoe an amateur builds, as a little experience teaches one that to get a satisfactory boat, the work must be done in a proper way which takes time, preparation and suitable materials. This does not mean any great increase in expense, and does insure a safe and durable boat, which will stand hard work, and require less repairing while in use.

The canoe here described, and the manner of constructing it, will be found satisfactory by anyone building for the first time. The experience then gained will enable a builder to build other models which will more closely meet individual wants than does this design, though this one is a very common type, and answers very well for still water.

In preparation for work on the canoe, it is necessary to have a building-horse, shown in Fig. 1. This is made of a plank 6″ x 2″ and 14′ long, with four pairs of legs 18″ long; the top edge of the plank being about 20″ from the floor. Also a bending-board, Fig. 2, made of three pieces of plank, 4′ long, and 12″ wide, and 2″ thick, held together with three pieces of 2″ plank, 6″ wide, nailed to the under side.

A steam box, Fig. 3 ,is made of four boards 7′ long, two of them 8″ wide, and the other two 12″ wide, and 3-4″ or 7-8″ thick. One end is closed by a piece of board nailed into the end, the other end fitted with a cover as shown. Legs are fitted at each end of a height to adapt the box to the steam kettle. An ordinary boiling kettle set on an oil stove, the top of the kettle just fitting a hole cut in the centre of one of the wider sides of the box, will give plently of steam. Rags can be used to make the joints between kettle and box tight, if any leaking of steam should occur.

Three forms are now to be made, one for the centre, *A*, Fig. 4, and two, *B*, for positions midway between the centre and ends of the keel. Full size drawings should be made of these forms on manila paper. A centre vertical line should be made in each drawing. By folding the paper on this line, and holding the paper against a window, you can tell when you have got the sides alike. The drawings are then laid on the wood forms and the outlines marked. A thin flexible strip of wood, with several strong pins driven through it, will help to get the curves true and well rounded. The forms are well made of matched boards, held together with cleats and cut out with a compass saw. The sides of a packing case will answer.

The two forms *B*, are beveled slightly on the edges to fit strips of wood running from end to end, as subsequently mentioned. The upper corners are cut out to receive the inwales which are set in far enough to leave a 1-4″ space between their outer edges and the lines of the forms. This is the thickness of the ribs, the edges of the forms giving the lines of the inside of the wooden skin, as will be decribed later.

The keel may now be laid upon the horse and temporarily fastened with a few screws. It is a strip of clear grained oak 12′ long, 1′ high, 7-8″ wide at the top and 1-2″ wide at bottom, each side having a 3-16″ bevel towards the bottom. Each end is halved on the under side for 6″ to receive the stem and stern pieces. These are of the same cross section as the keel, 33″ long, and halved on the inner side where they join the keel. Rabbets 1-4″ wide and 1-8″ deep are cut on the inner edges to receive the canvas covering. A drawing is made on paper of the curve for these pieces; then laid out on the bending board. Holes are bored in this board to receive round sticks which hold the bent peices, after steaming, until they are dry.

Old broom handles, or 1″ dowelling will serve for the sticks which should be about 1′ long. The holes should be a tight fit, so the sticks will remain rigid while holding the pieces being bent. The holes on the inner side must be set back from the line to provide for the thickness of the material being bent.

Two additional strips 40″ long, 1″ thick, 7-8″ wide on one side and 1 1-2″ on the other, are bent to the same shape as the stem and stern pieces, and are placed inside the latter, and along the ends of the keel, as shown in Fig. 1. The stem and stern pieces are fastened to the keel with several 3-4″ brass screws, holes being countersunk for the heads. Narrow boards are nailed to the end of the horse to support the stem and stern as shown in Fig. 1. The inner strengthening pieces are then fitted, and fastened with 1 1-2″ brass screws, holes being first bored and countersunk to avoid splitting. The centre form *A*, is now placed in position, and attached to the horse by two strips of wood 1″ square, one on each side of the keel, using screws for fastening.

The inwales are now fitted. They should be of clear oak, 14′ long, 1 1-4″ wide and 1-2″ thick. Place the centres on the centre form; bring the ends together at stem and stern, and fasten with cord. After seeing that the curves are true, mark the ends to the correct bevel with the inner pieces of stem and stern, and saw off so that the extreme ends will be about 3-8″ from the front edge of the inner end pieces. The inwales af-

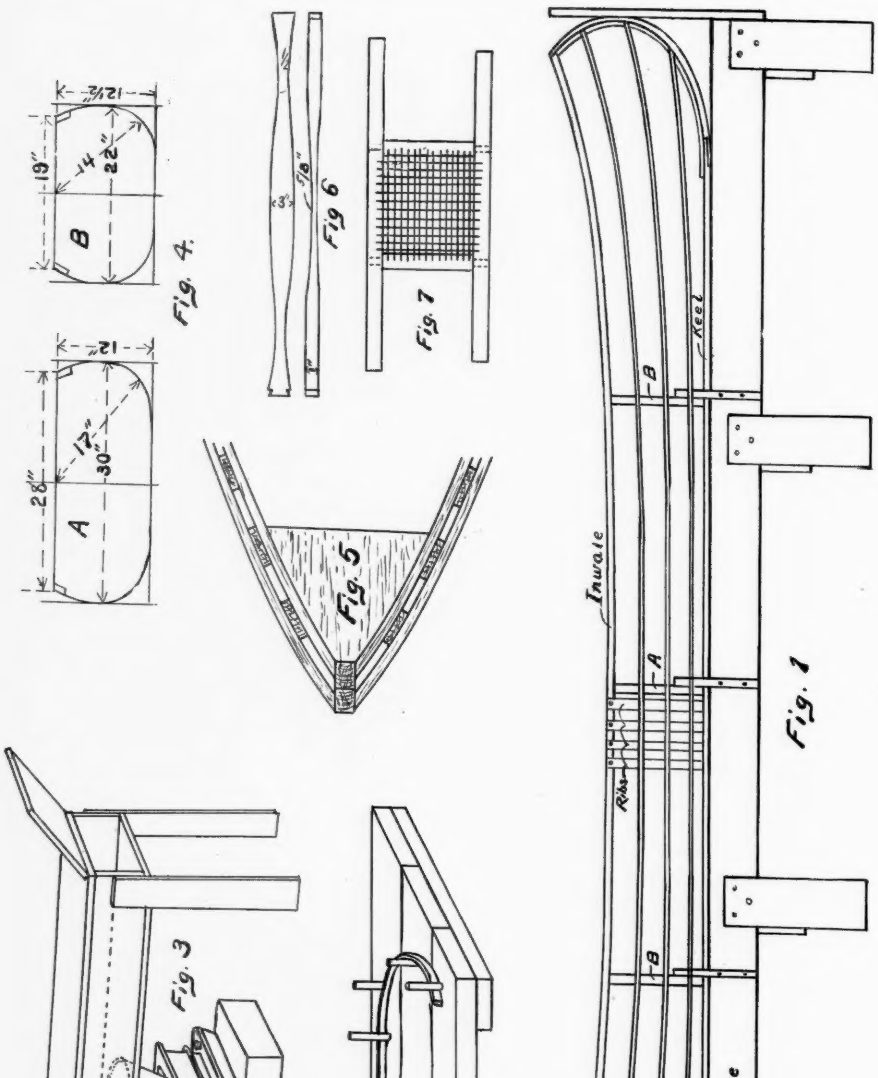


Fig. 1
Inwale
Ribs
Keel
Building Horse
A
B
Fig. 2
Fig. 3
Fig. 4.
A
B
28"
12"
17"
30"
19"
12½"
4"
22"
Fig. 5
Fig 6
Fig. 7

ter being very carefully fitted, are fastened with brass screws. V shaped blocks about 9″ long are then fitted between the ends of the inwales to give additional strength, and fastened with screws. Too much care cannot be used to see that this part of the work is done well.

The two sections *B*, are now placed in position, and temporarily fastened. Eight strips of clear spruce or oak, 14′ long, 1′ wide and 1-2″ thick are now placed at equal intervals along the outside of the forms as shown in Fig. 1. The centres are screwed to the centre form, the ends beveled off to fit the inner end pieces, as with the inwales, and fastened. By looking the frame over carefully from the ends and above, you can then determine if the forms *B*, are correctly located to give good lines. The natural curvature of these last mentioned strips, if the end fitting is well done, will be about right. Changes can be made by moving the forms *B*, to give more or less fullness as desired, but the reader is advised, if in doubt on this point, to incline towards considerable fullness, as anyone building for the first time is very apt to get the lines too fine, resulting in a cranky boat.

The ribs are now bent and fitted. The writer used hoops of sugar barrels in one canoe, and they answered very well. They are usually 1 1-2″ wide and 1-4″ thick. About 30 hoops will be needed if spaced 3″ apart. They should be carefully taken apart and straightened out, after soaking with hot water to make them pliable. When dry take off all splinters with a plane or spoke shave. If hoops are not available, 25 strips of ash 6′ long, 2″ wide and 1-4″ thick will be needed. The ribs each side of the forms are placed first. Give them a good steaming in the steam box, and while this is being done, bore holes in the bending-board for the sticks to receive the two shapes, one set being placed inside the other. When dry they are placed inside the frame, the centres fastened to the keel and the ends to the outer sides of the inwales with 3-4″ brass screws. The outer sides of the ribs should just touch the wooden strips which were placed lengthwise. By means of these strips the ribs can be rapidly and correctly fitted in place. The ribs should be bent so that wrenching is not necessary to secure the correct shape, and any rib which cannot be easily fitted should be re-bent. Two ribs of each shape are required, and six to eight can be bent with one set of holes by wedging with thin strips of wood, and changing the inner holes. The ribs at the ends of the canoe, are beveled at the ends to fit the keel and inwales.

The gunwales are now put in. They are of oak of the same size as the inwales, placed outside the ribs, and fastened to the latter with brass screws. The ends are beveled where they meet the outer stem and stern pieces. The frame is now ready for the wooden sheathing after giving the ribs a coating of lead paint. The sheathing is made of pine or white wood strips, 3″ wide, 1-8″ thick, and as long as can conveniently be obtained. Begin with a row against the gunwale, joints being centred on the ribs. Bevel the ends to fit the inner stem and stern pieces, and fasten to the ribs with copper tacks. Use tacks with small heads and wire guage, and make holes with an awl wherever there is any probability of splitting. A coating of lead paint will prevent warping caused by rain water or a capsize.

A second row of sheathing is put on, flush against the first row, the edges of the former being trimmed with a draw-knife. To find the amount of trimming necessary, fastened in place with a few tacks, allowing the strip to lap over those previously put on whenever necessary; mark with a pencil where the edges meet, and then take off and trim. In this way the sheathing will comform to the curve of the ribs, and present a smooth surface for the canvas. To put on the rows next to the keel, remove one of the pieces holding the forms, put on the sheathing, and then do the same with the other side, as the sheathing will hold the frame to shape. Any sharp edges should be taken off with a spoke-shave.

The forms should now be taken out, two or three strips of wood being fastened across the gunwales to hold the canoe to shape. A table top can be added to the horse, and used as a work table while putting on the canvas and finish. The canoe should next be given a coat of lead paint; floor paint being well adapted for the second coat. The canvas should be put on right after painting the sheathing, so that the paint when dry will bind the canvas to the sheathing.

The canvas should be a fine duck, at least 8 oz. weight. Small copper tacks should be used, and put very close together. Draw one edge taut along the keel, and temporarily fasten at a number of places with tacks, drawing out as many wrinkles as possible. Beginning at the centre of the keel, tack that edge of the canvas to the keel, as close to the sheathing as possible. Turn under a lap of about 1-4″. Pull the canvas endwise as much as possible, and tack down to within 2′ of the ends. Then tack down the edge at the gunwales cutting off a little at a time and turning under a 1-4″ lap. This edge is tacked to the under edge of the gunwale. The edges at the ends are tacked into the rabbet in the outer stem and stern pieces. A pair of plyers will be of much assistance in pulling the canvas to place.

The first coating of the canvas should be linseed oil and beeswax. Disolve six ounces of beeswax in a pint of alchohol so as to have a fluid mixture and add this mixture to a quart of linseed oil. Coat the canvas with this mixture and when dry, put on a coat of lead paint. If lead paint is applied directly to the canvas, a large quantity will be needed and the canoe be quite heavy, which is prevented by using the above mixture. If the last coat of paint is gone over with fine sandpaper, a coat of colored enamel will give a fine finish.

Strips of mahogany, 14″ long, 1 1-4″ wide and 3-8″ thick, can now be placed over the gunwale and inwale being fastened to them with round-headed brass

screws. The upper edges are rounded with a plane before putting on. These strips will probably have to be in two pieces owing to the difficulty in getting single strips that are long enough. Strips of half-round brass, 1-2" wide are fitted to stem and stern and along the ends of the keel. Holes are drilled and countersunk for brass screws placed about 6" apart.

Cross bars are put in about 4 1-2' from each end, tenons being cut on each end to fit mortises cut in the inwales. The cross-bars are shaped out as shown in Fig. 6, with a draw-knife, from pieces of oak about 21" long, 3" wide, and 7-8 thick. Frames are made for two seats, Fig. 7, cane or wood being used for covering. They are secured to the under sides of the inwales with long, brass screws, holes being bored with gimlets to prevent splitting.

A floor of 3-8" boards should be laid over the open sections to protect the sheathing. It should be built separately and fastened down to the ribs with brass screws, so that it may easily be renewed when desirable. The ends may also be decked over from 18" to 24" by putting in light cross pieces and covering with V shaped pieces of mahogany. It is customary to curve the inner ends of the deck when of this length.

Air tanks made of copper should be fitted to the bow, no canoe being safe to use without them. The writer has used three five-pound coffee cans, in each end. The covers were first soldered on, and the cans then soldered together with narrow strips of tin. Two coats of lead paint were then given the whole to prevent rust, and they were fastened in place by copper wire and screw-eyes. Always have the tanks of an open canoe securely fastened, or you may see them floating away just when you need them most. The tanks above mentioned, will easily support two adults, with the canoe filled with water. The reader is recommended to buy a paddle, which can be used as a model if the desire to make one is very strong. A mooring rope, cushions and other fittings may be added as desired.

HOW TO BUILD AN AUTOMOBILE

WILLIAM M. FRANCIS.

II. THE FRONT AXLE.

The front axle in Fig. 3, is besit 3 1-2" downward to allow clearance for the bottom of the engine, when the springs compress in jolting. This axle is a soft steel casting (boiler plate, melted) and cast in two pieces; making the fork to hold the steering knuckle, the plate to hold the spring, and the offset to the centre of the axle in one piece, and another exactly like it. The two pieces after being machined, are weilded together, as shown at centre of Fig. 3, giving the axle assembled as seen from the rear. The axle is of oblong section 1 1-8" x 1 3-8, with the greater width in the verticle plane, *D* is a section of the spring, clamped in place with the U bolts, *B*, is a view of the same part, looking at it from the under side, also showing a broken part of spring, while *C*, is an end view of the fork part. As the two ends of the axle are exactly alike, with the exception that the position of the lever, *E*, is the reverse on each end, and thread *F*, is on one end right, and the other left, the dimensions that are omitted on one end of the axle are on the other end, or on the part which it fits into.

The forks may be either centre lined on a surface plate, and clamped against an angle plate on a vertical drill, true to these lines and drilled from each side, inverting on the drill; or they may be drilled in the lathe, using the tail stock centre to guide the work as well as to feed. Drill in either case from each end of the fork, and leave a little to ream, (when all together), with a fluted reamer.

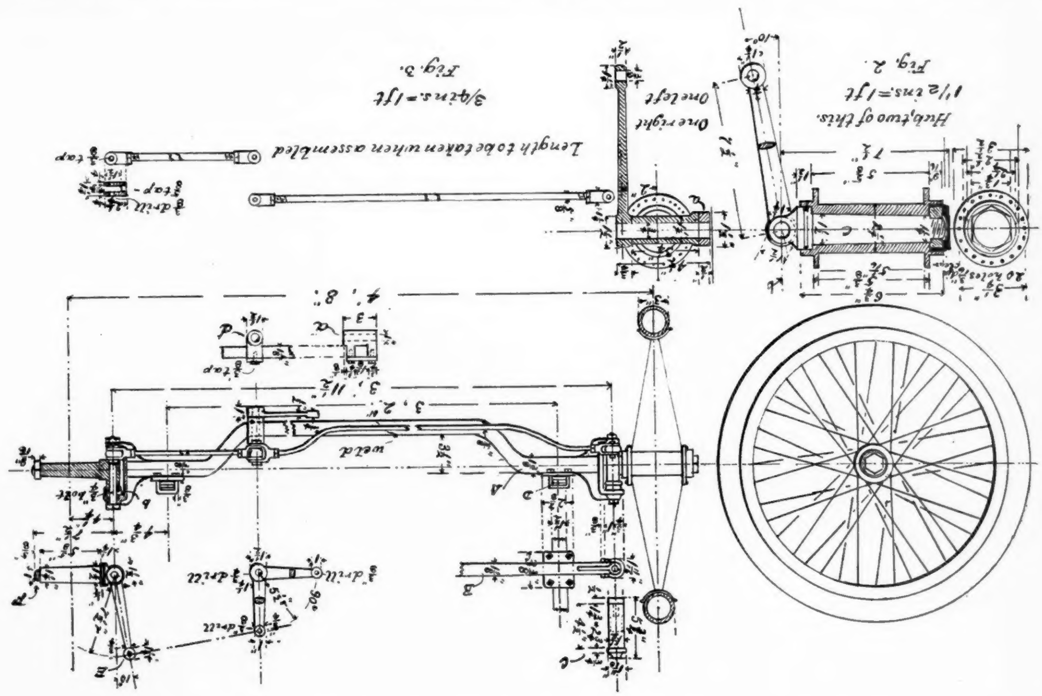
In the section of steering knuckles, shown in Fig. 2 at *a*, is a brass washer, in order that two steel surfaces may not wear against each other, but on the right hand end of axle, Fig. 3, is a ball bearing which is to be preferred, as it will be found that the friction of the tires makes the steering apparatus hard to move when the carriage is standing still, while this is not noticed when moving. This arrangement is designed to take a heavy pattern lower head, bearing of a bicycle. The recess for this will have to be bored with a small boring bar and cutter. Either of the above methods may be used.

The hub, Fig. 3. is longer then is generally used, and may be cast of Tobin bronze, which makes the machine work, easier to do, or steel with a composition bushing or ball bearings may be used. The tensils strength of steel and Tobin bronze are about equal. The hub may be chucked true wish the larger end of the hole out, the hole bored and the outside finished to the flange next to the chuck. After marking the centre circle for the spoke holes with a sharp V tool, reserve in the chuck, and true up, put the back rest on the smallest diameter of hub, bore, face and cut the thread for the dust cap shown in shaded part of Fig. 3, finish the outside and mark the spoke circle. Nearly all standard rims are drilled for 40 spokes so that there will be 20 holes in eachend of the hub to allow 3-16" spokes to slip through freely. In lacing these, every other spoke runs taugent with the hub.

The drawing shows the spokes on the front end of hub in full lines, and those on the back end in broken lines. The easiest way to bore the taper hole in the hub, is to use the back taper attachment similiar to that on the Lodge-Davis lathe.

The axle may now be turned to fit the hub. Before taking a final cut on the taper part, it is well to draw three or four chalk lines lengthwise on it, and try it in the hole with a turning motion. If it is in the right taper, the lines will be nearly rubbed out, but if wrong

distribute the oil. It should also be straight, as any tendency to a spiral will carry all the oil to one end of the bearing. While the axle is on the centres, set the tail stock over centaal and take a V tool and mark line. *B*, Fig. 2, across each end of the boat hub. Block the dog which drives the work in the face plate, after having set a tool the same height as the tail centre, and scratch line *c*, Fig. 2, to cross line *b*. Now revolve the lathe one-half a revolution and repeat on the other end of bolt hub. The intersection of these lines is the



one end only will be blackened and you will have to alter the setting of the tail stock. File up finally good and smooth and polish with emery cloth. A groove about 1-4″ and 1-4″ deep, is turned in the large diameter with a cutting off tool, in which wind enough worsted yarn so that you can just get it in the hub. Finish up with three or four half hitches. The yarn is to keep dirt out of the bearing. As before mentioned, one of the axes is to have a right hand thread cut on it and the other a left, so that if the nut was left loose, the wheel would have a tendency to screw it on rather than off. The nuts for this had better be done first with about 10 threads per inch as the nut is thin. It is easiest to fit the axles to the nuts. An oil groove is also to be cut on the axle than in the hub, and it lasts longer. End it at about 1-4″ from the shoulders. If not, it will have a tendency to run the oil out of the bearing instead of making a reservoir to

centre of the bolt hole. Lay out and drill the hole half way through from each end, drilling on the lathe centre. Leave enough to ream. The end of the bolt hub may now be bored and turned either on an arbor or using the bolt itself as a centre hole. The washer *a*, is now finished and the fork axle and washer put together and a fluted reamer run through. As a precaution, after the nut is fitted, it is a wise thing to have a cotter pin through the end of axle, also to keep the nut from backing off. The hole in the end of the steering lever on axle is near enough right if bored in the centre of the boss on the casting and faced up with a counter-bore. Any little out on this may be twisted or bent into shape.

The piece *d*, Fig. 3, is either a steel forging or casting and should drive on the axle and be pinned. The rest of the work consists mostly of drilling and fitting which will require no explanation.

A 1-4 H. P. HORIZONTAL ENGINE

B. R. Wicks.

III. PISTON AND PISTON VALVE.

There will be six No. 28 holes drilled in the back cylinder cover, No. 356, the front cylinder cover, No. 357., the back valve chest cover No. 362, and the front valve chest cover, No. 362, to hold them in their respective positions on the cylinder, cross head guides and valve chest.

Begin with the front and back cylinder covers, Nos. 356 and 357, make a light prick-punch mark on the 1 3-4 circle for a starting point, and with a pair of dividers, divide this circle into six equal parts, making a prick-punch mark at each point. Then take the front cover, No. 357, and divide up for the same number of holes, in the same way.

The valve chest covers Nos. 362 and 363, are also to have six No. 28 holes drilled in them to hold them in place on the two extensions on the valve chest. Divide the 1″ circle made on these covers, using the same rule as with the front and back cylinder heads. Drill the holes in all four covers with a No. 28 twist drill;it will be found that after the drill passes through these covers that there is a small burn left from the drill: this can be taken off by turning a pointed scraper around the holes a few times by the hands.

In the flange of the cross head guide No. 367, there are also six No. 28 holes drilled to hold the cross head guide and the front cylinder cover in position to the cylinder. In drilling these six holes the front cylinder cover will have to be used as a gig, so that the holes in the front cylinder cover, and in the flange of the cross head guide, will match exactly with each other.

The cross head guide being over 3″ in length, it will be difficult to drill the holes in the flange, and prevent the casting tipping one way or another, thus making bad holes and breaking drills, without some kind of a support to keep it in a rigid position during the drilling. A support that will answer can very easily be made, and it will pay for the time it takes to makes it The support can be made from a casting. The bottom which will rest on the drill pad, or drill press table should be about 3″ and 3-8″ thick, so that a good substantial bearing can be obtained. There should be a boss or plug on the top so that it can be turned to fit the 1 1-4″ hole in the cross head guide. This should be placed on centres and the plug part turned to tap lightly in the 1 1-4″ hole to a depth of about 1 1-2″. The 3″ bottoms should face off straight.

Take the front cylinder cover, No. 357, and note the position of the holes on the detail drawings; tap the cover in place on the cross head guide and securly clamp the two together with a small clamp placed between the holes. Tap the plug of the support in the other end. Now drill six holes in the flange of the cross head guide with a No. 28 twist drill, using the front cylinder cover as a gig. Before taking the cover from its place on the guide or removing the clamp, with a sharp scriver make a guide line across the edge of the cover and flange so that, in putting these parts together again, it will be known just how they are to go. The cover can now be taken out and also the support as all the drilling in the flange of the cross head guide is completed. The two holes for the piston rod gland studs No. 361 can now be spotted, drilled and tapped.

Take the front cylinder cover No. 357. and set it up against a small angle plate, set on the surface plate and clamp it to the angle plate by the extreme side of the 1″ 3-32 diameter; place a small thin square against it and set the top and bottom holes in the flange exactly central with each other; that is, when the square is placed at the centre of the top hole, the bottom one should be the same. The cover can be tapped until this position is located.

With a scratch block or surface gauge find the dead centre of the 15-16″ boss and make a line across to set the piston rod gland, No. 360, in position for spotting and dlriling for the two piston-rod gland studs, No. 361. Remove the clamp and take the front cylinder head from the angle plate, and take the piston rod gland that has been drilled with a No. 28 drill and placed in the piston rod stuffing box. The centre line made across the 15-16″ diameter hub. can be plainly seen through the two No. 28 holes drilled in the piston rod gland. Set the gland so that this centre line will divide the two holes in half, and clamp the two pieces together, using the gland as a gig.

Spot the hub with a No. 35 twist drill about 1-32″ deep, and follow with a No. 35 twist drill (the size tap drill for 9-64-32″ threads per inch) to the depth of 3-8″. Before taking off the clamp, tap these two holes out with a 9-64-32″ thread machine tap. Which finishes all the drilling and tapping on the front cylinder cover No. 357. The front valve chest cover, No. 363, is laid out, spotted, drilled, and tapped for the valve stem gland, No. 365, in the same way, using tne same sizes, drills, and taps. The cylinder flanges may now be spotted, drilled and tapped, the front and back cover being used as gigs. Take the cylinder, No. 354, lay it down lengthwise on the surface plate, set the square against the face of the 17″ flange and find one-half the diameter of the 1 1-2″ bore. Make a line only on the top, turn it end for end and treat the other flange in the same way.

Take the back cylinder cover, No. 356, and place it in position, make the top hole to be equal half on each side ot the centre and clamp it in position. With a No. 28 drill, spot all the six holes 1-32″ deep, and follow with the No. 35 drill. Make this hole 3-8″ deep, make a mark so that in putting together again, their exact position will be known. The front cylinder cover is done in the same way, also the front and back valve chest cover. After all the 24 holes have been spotted and drilled, tap out with a 9-64″-32 V thread machine tap. It would be well to have two of these taps, a taper and bottoming tap, start in with the taper and finish up to the depth with the bottoming, using lard oil and work the taps very carefully, so as not to break them off in the circular flange.

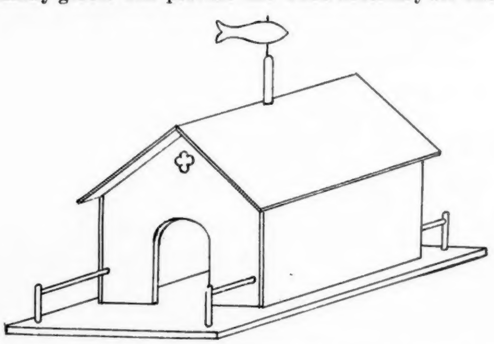
The piston casting No. 358, should be held in a chuck and centered with the centreing tool, so that a 15-16″ twist drill will start fair. Drill the hole all the way through the castings, and before removing from the chuck, rough out the recess for the piston rod nut within a 1-16″ of the sizes given in the detail drawings. Also turn off as far as possible the outside diameter to 1 9-16″ and ream out the 15-64″ hole with a 1-4 reamer. The casting can now be taken out of the chuck and turned end for end, taking care that it runs true with the turning just done. and turn to 1 9-16″ and the side faced off. Having this roughing operation finished, to complete the finishing, it will have to be forced on a 1-4″ mandrel, turn the outside diameter which is 1 1-2″ by taking light cuts so that it will slide nicely in the bore of the cylinder with no shake, and face the two sides, making the width 1-2″ as per detail drawings. There will have to be two grooves cut in the piston, 1 3-8″ diameter and 1-8″ wide, to receive the two piston packing rings, No. 359. These grooves are cut in with two parting tools, the one to be used first is 1-16″ wide, finishing up with 1-8″ wide. In making these grooves take care and not spring the mandrel. The casting will now be rechucked again. Take great care that it runs dead true with the boring and turning, and finish out the recess with a boring tool in the slide rest to 3-4″ diameter, and 1-4″ to receive the piston rod nut. This finishes the machine work on the piston.

JUNIOR DEPARTMENT

For the Instruction and Information of Younger Readers.

A SMALL BIRD-HOUSE.

The birds are again with us which suggests building a home for them to summer in. A pine box from the family grocer will provide the wood necessary for one



of the size here described, and any bright boy with a few tools can easily make it. The base is 13″ long, 9″ wide, and should be at least 5-8″ thick, 3-4,′ thick is better. The two side pieces are 8″ long, 4″ high, and not over I-4″ thick. The end pieces are 6″ long, 4″ high at the ends, and 7″ high at the centre. The two pieces for the roof are 12″ long, and 6″ wide, beveled where they join at the top and also at the bottom edges.

Doors are cut in the end pieces as shown in the illustration, 2 1-2″ wide, and 3″ high in the centre, with rounded corners. This can easily be done with a fret saw, lacking which, bore holes in the corners with a 1″ bit, saw down to the outer edges with a hand saw, and cut across the top with a knife or chisel. A ventilating hole is also made, the centre of which should be 2″ from the top. This can be easily done by boring four holes with a 3-4 bit, so spaced that the inner edges cut into each other.

The house can now be nailed together. Holes are then bored in each corner of the base-board to receive round posts 1-4″ in diameter, and 2″ long. Before putting in these posts, bore small holes near the top ends to receive round cross pieces, the centre ends of which fit into holes bored in the ends of the house. Beef skewers will answer for these pieces, the holes being made of a size to fit them. These form good landing places for the birds, and also make the house more attractive. A cupola or vane may also be added, the latter being shown in the shape of a fish. It is made of a piece of 1-2″ wood, 7″ long, and 3″ wide, A hole for the vane-rod is bored or burned through it.

2 1-2″ from end. The vane-rod should be brass, a piece of small curtain rod 6″ long will do; the lower end being driven into a piece of wood which projects 4″ above the roof, and reaches to the base-board, where it is held firmly by a screw put up through the bottom.

A partition should be placed in the centre of the house, making two places for nests. If the house is to rest on a pole, a round tin spice-box should be fastened to the centre of the under side of the base-board by several short screws, holes being punched with large nails for them. The spice-box should be of a size to fit the pole so that wind will not dislodge the house. It can be painted as desired, the roof and base-board being darker than the rest of the house.

TOOLS AND THEIR USES.

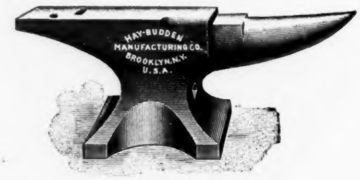
The subject of tools for an amateur is an important one, inasmuch as the work done with them is usually quite as much for the pleasure of using them as for any utility of the article made. In selecting tools, therefore, too much care cannot be used, both as to quality and variety. It should be needless to say, that, once secured, tools should be kept in good condition, but too often they are allowed to lay around and become dull and rusty. Good work cannot be done with poor tools and our readers are cautioned against shiftless habits in handling their tools. If one has not already a proper chest or cabinet for tools, make one as soon as the time will permit, and make it a practice to return all tools to it when through using, even if you expect to resume their use in a short time.

It is also advisable to buy a good quality of tools; not necessarily the highest cost, but put enough money into them to insure servicable ones. The cheapest grades are often made of such poor material as to soon break or become dull; are without important and useful features or are imperfect in some way, and therefore undesirable. It is also best to buy as the work brings the need, after the most commonly used and necessary tools have been obtained.

Tool chests with the tools already in them are expensive, and unless a high price is paid, are of poor quality and include many tools for which there is little or no use. Buy at a regular hardware store. Department and toy store tools are usually for selling purposes only.

With this brief introduction the description and uses of the tools required in wood working and cabinet making will begin. The arrangement is alphabetical to facilitate ready reference at any time.

ANVIL. An anvil is a heavy mass of iron, more commonly used in metal working, but often useful to the wood worker. A projecting horn allows curved work to be formed, and a socket on the other end, receives cutting off and other tools. A good substitute is a short piece of structural iron, which can often be obtained for a small sum where the iron for city buildings is manufactured.



AUGER BITS. (See Bits.)

AWL. This simple but well known tool, should have a sharp cutting edge, as its work is to cut and push aside the fibres of the wood without removing any. On this account holes to receive nails or screws are many times preferably made with an awl, as the wood then has a tendency to return to its original place, closing around the nail or screw and holding it firmly in position.

The cutting edge should be used across the grain to avoid splitting the wood. Press the awl down into the wood firmly and evenly, If not too near the edge of the wood, it may be twisted if the hole is to be a deep one. An awl may be sharpened on an oil stone, until the edge is pretty well worn down, when it should be removed from the handle and repointed. To do this, heat to a cherry red in a fire, and lightly hammer both sides until the original shape is secured. Again heat to a cherry red and plunge quickly into water to temper, after which, sharpen on the oil stone. It is desirable to have several sizes, fitted to hardwood handles.

A *Marking or Scratch-Awl* has a round sharp point and is used for marking guide lines. With a chalk-line, a scratch-awl is used for marking long lines for laying shingles and clapboards. The awl is placed through the loop at one end of the cord and then pushed into the wood at one end of the line to be marked. As you move towards the other end of the line, the cord is held against a piece of white or blue chalk, thus becoming coated with particles of the latter. Arriving at the other end of the line, draw the cord taut and hold it firmly on the line by the thumb. Lift the cord straight away from the surface, with the thumb and forefinger of the free hand, at a central point between the two ends or as far from one end as possible, and then quickly released, so that the cord will snapk bac on the line. The chalk on the line will adhere to the surface clearly marking it. If the cord is not held squarly over the line, the marking will not be straight.

TRADE NOTES

The 1903 Calalog of Brown & Sharpe Mfg. Co., Providence, R. I., has been received. The professional has for many years found this book of great value, and most of them possess a copy. The amateur will also find it a great help.